

VESDA®

ASD Suppression Actuation Threshold (ASAT) Calculator

Product Guide

July 2007

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Preface

The ASD Suppression Actuation Threshold (ASAT) Calculator is a Microsoft Excel based software tool, developed using Computational Fluid Dynamics (CFD) fire modeling techniques.

The function of this tool is to calculate appropriate VESDA alarm thresholds for the purpose of suppression actuation, under a variety of different environmental conditions and for a number of different suppression actuation schemes.

Approvals

The ASAT Calculator tool has FM Global approval (FM Standard 3230-3250).

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1. Coincidence/Double Knock Detection Schemes

One method for minimizing the possibility of false discharges involves using a coincidence (double knock) detection scheme. The “coincidence connection” configuration requires that at least two independent detector alarm outputs be signalled to the detection control and indicating equipment before suppression is actuated.

Making coincidence (double knock) detection a prerequisite to suppression actuation, avoids unnecessary false alarm triggered suppression releases.

There are five suggested coincidence (double knock) detection options, for which the ASAT Calculator will determine appropriate VESDA alarm threshold levels for suppression actuation:

1. Hybrid Detection Technologies Option – Point (spot) type smoke detectors and VESDA detectors, both either on the ceiling or within the floor void, together form a coincidence detection scheme.
2. Alternating VESDA Sampling Pipe Option – Two different VESDA detectors, with their respective sampling pipes alternated, both either on the ceiling or within the floor void, can maintain the required sampling hole spacing while providing two independent detectors for coincidence detection.
3. VESDA Detector Exhaust Sampling Option – Coincidence detection is provided by one VESDA detector sampling the exhausts of up to four other VESDA detectors on the ceiling, in the floor void or both.
4. VESDA Ceiling (Floor Void)/AHU Sampling Option – Two different VESDA detectors, one with its sampling pipe mounted on the ceiling (or in the floor void) and the other across the AHU's return air vent, provide coincidence detection.
5. Single VESDA Detector Options – (a) Two of the VESDA system multiple alarm levels can be set at appropriate levels to provide a coincidence detection scheme using a single VESDA detector. The alarm setting should be comparable to that for conventional point (spot) type smoke detectors, (b) Pairs of adjacent VESDA LaserSCANNER (VLS) sampling pipes may also be used to provide two alarms. One advantage of using this option is having two signals from two independent detection sectors.

For more information on any of these options, refer to the Telecommunications And Data Processing Facilities Design Guide (Xtralis Document Number 11782).

2. Using The ASAT Calculator

2.1 General Use

The instructions in this Section will guide you through the use of the ASAT Calculator to determine the appropriate VESDA alarm thresholds for coincidence detection (double knock) options 1, 2, 4 and 5 above. Coincidence detection (double knock) option 3 is addressed in Section 2.2.

1. Double click on the ASAT Calculator file name to open it in Microsoft Excel.
2. Enable Macros to display the initial screen of the ASAT Calculator (Figure 1).

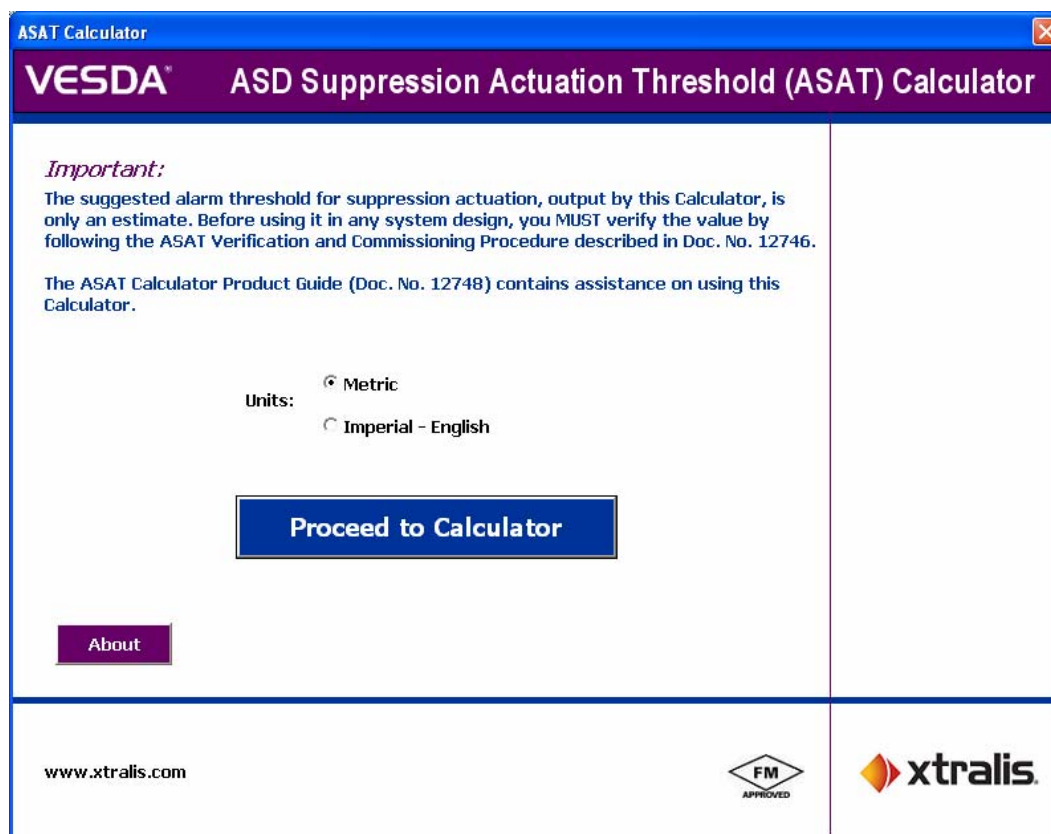


Figure 1 – Initial screen of the ASAT Calculator.

3. Select the **Units** you want your calculations in by clicking the corresponding radio button.
4. Click on the **About** button, if you would like to view product information.
5. Click on the **Proceed to Calculator** button, if you are ready to make calculations. The following screen (Figure 2) will be displayed. Note that, had you selected **Imperial** units, the screen displayed would reflect this selection.

ASAT Calculator

VESDA® ASD Suppression Actuation Threshold (ASAT) Calculator

Project

Detection Method

☒ Equivalent to point (spot) type smoke detectors, ceiling

☐ Equivalent to point (spot) type smoke detectors, floor void

Design Parameters

Main Space

Air change rate changes/hour

Enclosure area m²

Enclosure height m

Nominal point (spot) type smoke detector sensitivity %Obs/m

Preferred VESDA sampling hole spacing m

☒ CRAC Units

☐ Vertical Air Circulation (upflow or downflow)

Calculate

VESDA Exhaust Sampling

Fire alarm settings and procedure:

Details

Figure 2 – ASAT Calculator main screen.

6. Under **Detection Method**, select the type of enclosure by clicking on the radio button (ceiling or floor void).
7. In the text boxes under **Design Parameters**, enter the air change rate in the area to be protected, room area, the ceiling height, the nominal point (spot) type smoke detector sensitivity that you wish the VESDA system to be equivalent to and the preferred sampling hole spacing. For air change rates of less than 5 per hour, you should use the group sensitivity feature of ASPIRE2 to determine the alarm threshold. This feature is discussed later under “ASAT Fire Alarm Threshold Evaluation In ASPIRE2” section 3.
8. Select the type of return air circulation, most appropriate to the area to be protected, by clicking on the radio button. CRAC stands for Computer Room Air Conditioning.
9. Click on the **Calculate** button. The following screen (Figure 3) will be displayed.

ASAT Calculator

VESDA® ASD Suppression Actuation Threshold (ASAT) Calculator

Project

Detection Method

- ☒ Equivalent to point (spot) type smoke detectors, ceiling
- ☐ Equivalent to point (spot) type smoke detectors, floor void

Design Parameters

Main Space

Air change rate changes/hour

Enclosure area m²

Enclosure height m

Nominal point (spot) type smoke detector sensitivity %Obs/m

Preferred VESDA sampling hole spacing m

☒ CRAC Units

☐ Vertical Air Circulation (upflow or downflow)

Calculate

Design Recommendations

ASD Suppression Actuation Threshold:
1.599 %Obs/m

This is an estimated VESDA Fire alarm setting.

Maximum number of sampling holes:
9

The ASPIRE2 modeling tool must be used for detailed pipe network design.

The ASAT Verification and Commissioning Procedure must be followed before the system is brought into operation.

VESDA Exhaust Sampling

Fire alarm settings and procedure:

Details

Figure 3 – Screen showing the results from the ASAT Calculator.

The suppression actuation threshold is displayed on the right of the screen, along with the maximum number of sampling holes.

Table 1 gives the maximum number of sampling holes allowed for each VESDA detector type.

Table 1 – Maximum number of sampling holes for each VESDA detector type.

Detector Type	Max allowed no. of sampling holes
VLF-250	12
VLF-500	25
VLC	40
VLP	100

Note: You must also consult and adhere to any local codes and standards recommendations on detection point spacing

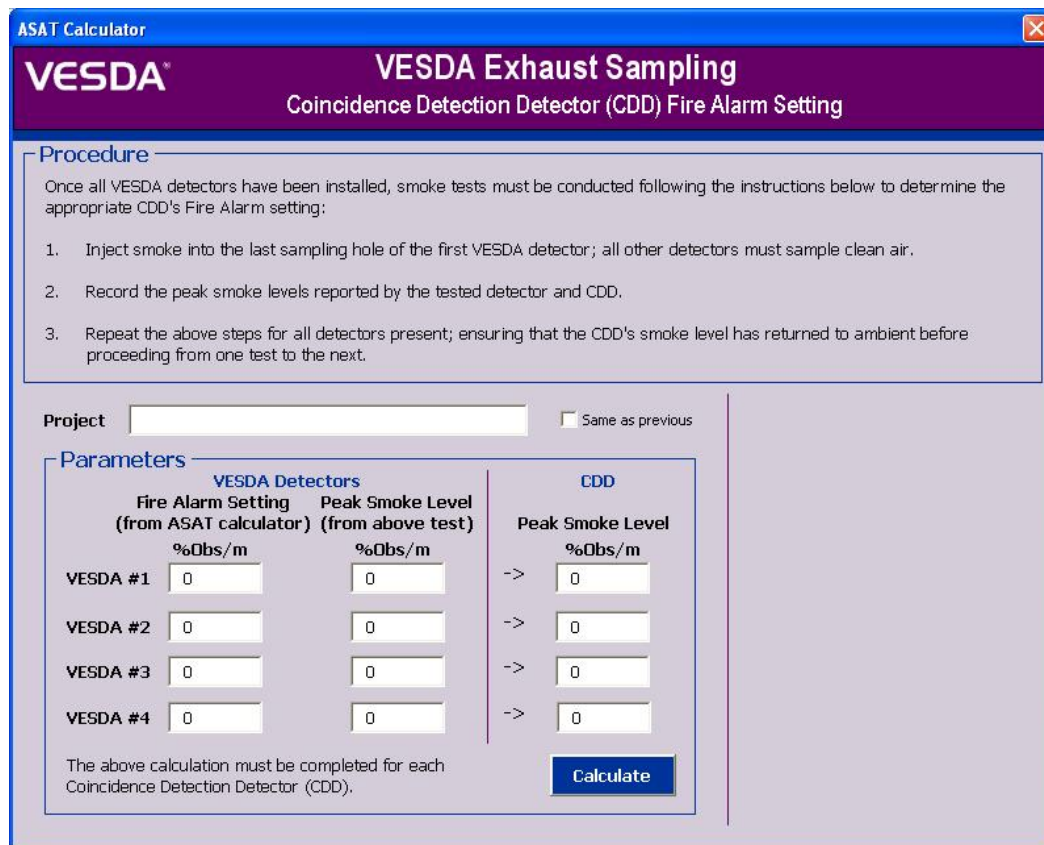
The ASAT Calculator produces a log as part of its calculation process. This log, an Excel spreadsheet, contains a record of the input and output parameters of the calculations performed. To view this log, move the ASAT Calculator dialog box aside by dragging and dropping it. The under lying spreadsheet can be printed using the **Print** option on the **File** menu in Excel.

WARNING: The VESDA alarm thresholds calculated by this tool are estimates only. They **MUST** be verified using the ASAT Verification and Commissioning Procedure (Xtralis Document Number 12746), before the system is put into operation.

2.2 VESDA Detector Exhaust Sampling

If you are employing the coincidence detection option involving VESDA detector exhaust sampling (that is, option 3 in Section 1), you must determine peak smoke levels for each of the VESDA detectors whose exhausts will be sampled.

1. Click on the **Details** button under **VESDA Exhaust Sampling** in Figure 3. The following screen (Figure 4) will be displayed.



ASAT Calculator

VESDA Exhaust Sampling

Coincidence Detection Detector (CDD) Fire Alarm Setting

Procedure

Once all VESDA detectors have been installed, smoke tests must be conducted following the instructions below to determine the appropriate CDD's Fire Alarm setting:

1. Inject smoke into the last sampling hole of the first VESDA detector; all other detectors must sample clean air.
2. Record the peak smoke levels reported by the tested detector and CDD.
3. Repeat the above steps for all detectors present; ensuring that the CDD's smoke level has returned to ambient before proceeding from one test to the next.

Project ☐ Same as previous

Parameters

	VESDA Detectors			CDD
	Fire Alarm Setting (from ASAT calculator)	Peak Smoke Level (from above test)		Peak Smoke Level
	%Obs/m	%Obs/m		%Obs/m
VESDA #1	0	0	->	0
VESDA #2	0	0	->	0
VESDA #3	0	0	->	0
VESDA #4	0	0	->	0

The above calculation must be completed for each Coincidence Detection Detector (CDD).

Calculate

Figure 4 – ASAT Screen showing the test procedure needed to calculate the appropriate alarm threshold for the exhaust sampling detector.

2. Check the **Same as previous** box if the project is of the same name as on the previous screen (Figure 3).
3. Follow the procedure outlined in the above screen (Figure 4).
4. Enter the peak smoke levels obtained for each of the VESDA detectors whose exhausts will be sampled. Up to four VESDA detectors can have their exhausts sampled by another VESDA Coincidence Detection Detector (CDD).
5. Click the **Calculate** button to obtain the alarm threshold for the CDD, based on the number and sensitivities of the VESDA detectors. The result will be displayed on the right as shown (Figure 5).

ASAT Calculator

VESDA®

VESDA Exhaust Sampling
Coincidence Detection Detector (CDD) Fire Alarm Setting

Procedure

Once all VESDA detectors have been installed, smoke tests must be conducted following the instructions below to determine the appropriate CDD's Fire Alarm setting:

1. Inject smoke into the last sampling hole of the first VESDA detector; all other detectors must sample clean air.
2. Record the peak smoke levels reported by the tested detector and CDD.
3. Repeat the above steps for all detectors present; ensuring that the CDD's smoke level has returned to ambient before proceeding from one test to the next.

Project ☐ Same as previous

Parameters

VESDA Detectors		CDD	
Fire Alarm Setting (from ASAT calculator)	Peak Smoke Level (from above test)		Peak Smoke Level
%Obs/m	%Obs/m		%Obs/m
VESDA #1	1.599	1	0.5
VESDA #2	0	0	0
VESDA #3	0	0	0
VESDA #4	0	0	0

The above calculation must be completed for each Coincidence Detection Detector (CDD).

Calculate

Fire Alarm Setting

CDD	(%Obs/m)
#1	0.72

If more than one CDD: **Add Detector**

Figure 5 – ASAT screen showing the CDD alarm threshold appropriate to the number of VESDA detectors and their sensitivities.

6. If you have more VESDA detectors with a corresponding CDD, you can repeat the above steps by clicking on the **Add Detector** button to display Figure 4.

2.3 ASAT Fire Alarm Threshold Adjustment

The ASAT **Fire** alarm threshold, determined previously, only applies to one VESDA detector assigned for the protection of the entire enclosure. When two or more VESDA detectors are required to cover the entire enclosure, the ASAT **Fire** alarm threshold must be adjusted. The objective of these adjustments is to achieve identical sampling hole sensitivity across all VESDA detectors.

Follow the steps below to make the necessary adjustments:

1. Take note of the ASAT Calculator, generated, **Fire** alarm threshold and total number of sampling holes, as determined in Section 2.1.
2. Determine the number of detectors required in the protected enclosure (detail design).
3. Determine the number of sampling holes contributed by each detector (Table 1).
4. The adjusted ASAT **Fire** alarm threshold for each detector is determined by the following formula:

$$\text{Detector (Fire Alarm)} = \frac{\text{ASAT Value} \times \text{Total No. of Sampling Holes}}{\text{No. of Sampling Holes for Detector}}$$

For example, consider an area with the following parameters:

- Enclosure area: 1800 m² (19,365 sq.ft),
- Air change rate/hour: 30 ACH,
- Enclosure height: 3 m (10 ft),
- Point (spot) type smoke detector nominal sensitivity: 5%Obs/m (1.5%Obs/ft),
- VESDA sampling hole spacing: 5 m (16.5 ft).

The ASAT Calculator Outputs are as follows:

- **Fire** alarm threshold: 0.285%Obs/m (0.086%Obs/ft),
- Total No. of sampling holes: 72.

Table 2 shows the adjusted ASAT **Fire** threshold for different design cases. Note that Table 2 takes into account the maximum number of sampling holes for each VESDA detector type as presented in Table 1.

Table 2: Adjusted ASAT Fire alarm threshold

Design Case	No. & Type of Detectors	No. of Sampling Holes per Detector	Adjusted ASAT Fire Threshold per Detector -%Obs/m (%Obs/ft)
1	1 x VLP	VLP = 72	0.285 (0.086)*
2	2 x VLC	VLC (1) = 36	0.570 (0.174)
		VLC (2) = 36	0.570 (0.174)
3	1 x VLC	VLC = 40	0.513 (0.156)
	1 x VLF-250	VLF-250 = 12	1.710 (0.521)
	1 x VLF-500	VLF-500 = 20	1.026 (0.313)
4	3 x VLF-500	VLF-500 (1) = 24	0.855 (0.261)
		VLF-500 (2) = 24	0.855 (0.261)
		VLF-500 (3) = 24	0.855 (0.261)
5	2 x VLF-250 2 x VLF-500	VLF-250 (1) = 12	1.71 (0.521)
		VLF-250 (2) = 12	1.71 (0.521)
		VLF-500 (1) = 24	0.855 (0.261)
		VLF-500 (2) = 24	0.855 (0.261)

* This value corresponds to the ASAT output since one VESDA detector is assigned for the entire enclosure.

3. ASAT *Fire* Alarm Threshold Evaluation In ASPIRE2

The ASPIRE2 Pipe Network Modeling Program can be used to evaluate the VESDA **Fire** alarm thresholds output by the ASAT Calculator. This evaluation involves the use of an ASPIRE2 advanced feature known as Group Sensitivity.

The use of Groups allows a collection of sampling holes (Figure 6) to have the same performance target and be treated the same by ASPIRE2. Normally, all sampling holes on a pipe network would be a single group, however, this is not always appropriate.

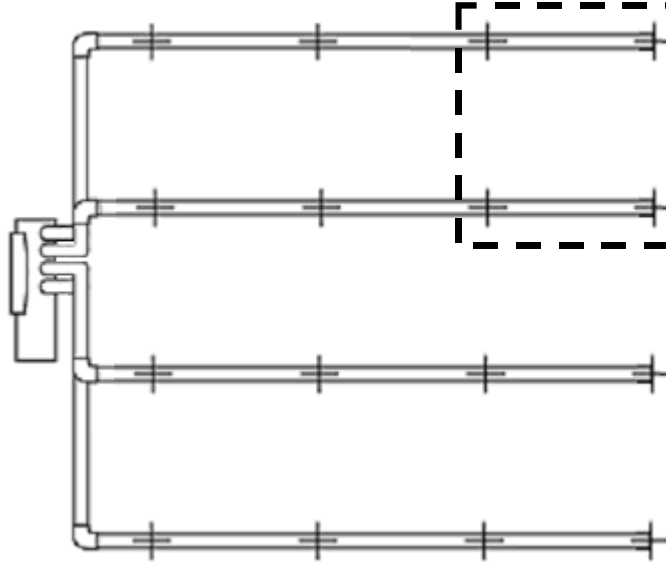


Figure 6 – Example of grouped sampling holes (four holes group).

The Groups feature allows you to flexibly assign sampling holes to groups and place different aggregate sensitivity constraints on each group. A collection of sampling holes that are in a slightly different environment to other sampling holes in their pipe network can be put in a separate group. For example, where there are sampling pipes on the ceiling of a room with a number of sampling holes covering a return air vent, the return air sampling holes can be grouped to ensure that they are treated consistently. Groups can also be used where a different aggregate sensitivity is required at the return air vent than at the ceiling.

The flow chart (Figure 7) outlines the steps to be followed when using ASPIRE2 to evaluate the **Fire** alarm thresholds output by the ASAT Calculator.

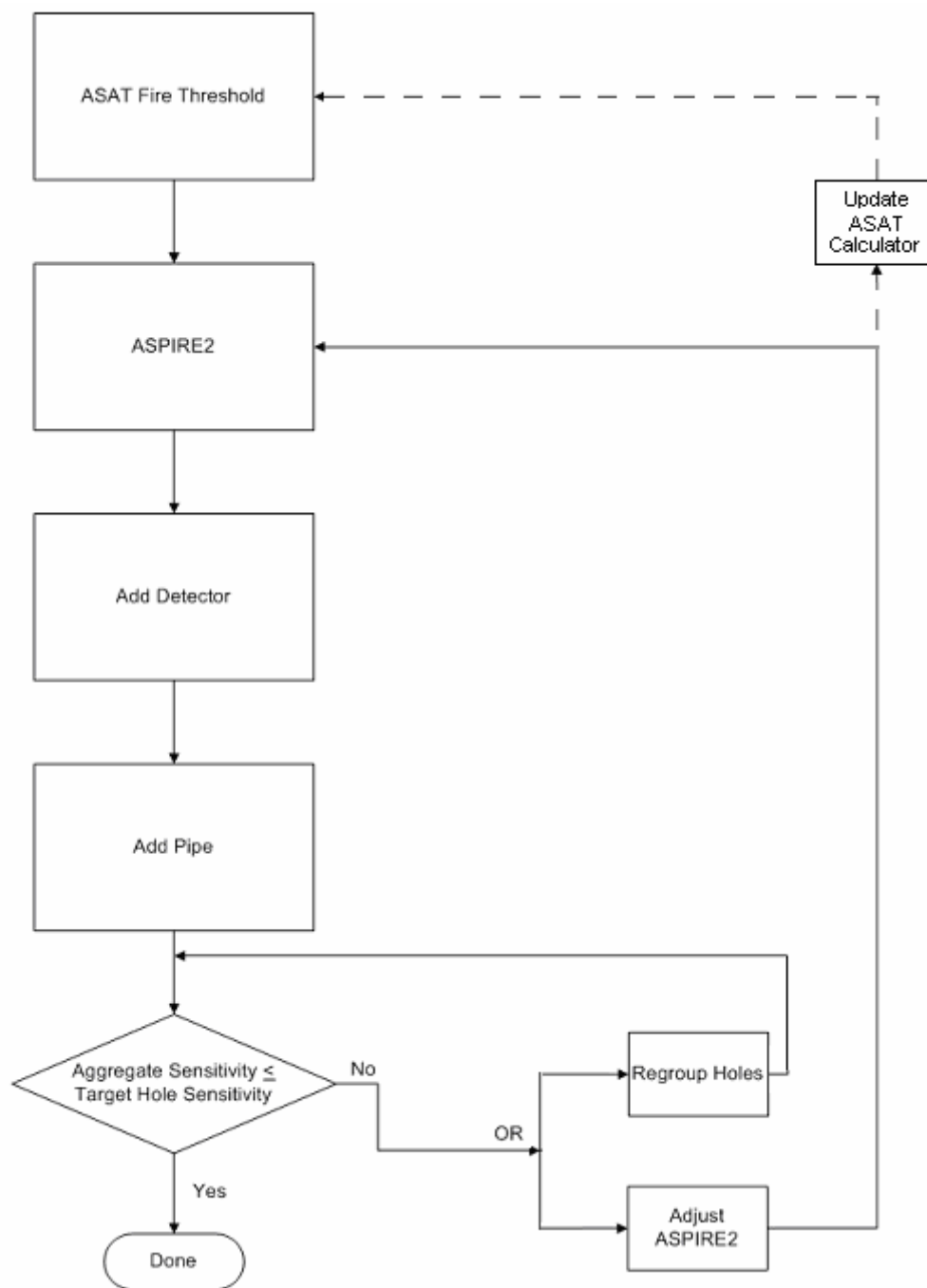


Figure 7 – Flow chart illustrating the process for ASPIRE2 evaluation of ASAT Calculator **Fire** alarm thresholds.

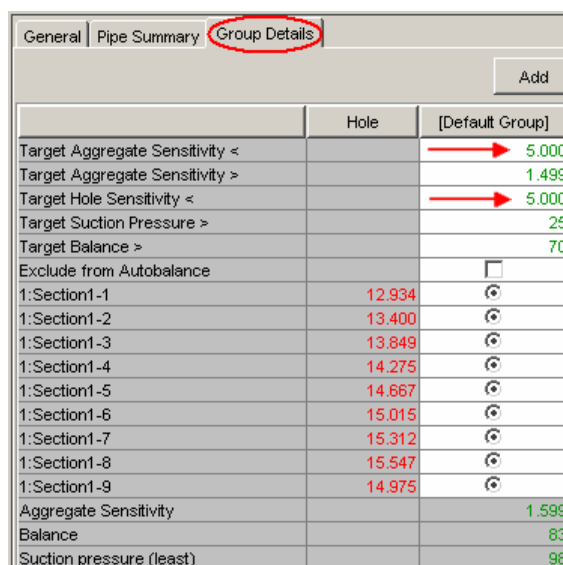
The example below involves two point (spot) type smoke detectors with sensitivity of 5%Obs/m (1.5%Obs/ft) being used to provide coincidence (double knock) detection for suppression actuation. Suppose that, the relevant information has been input to the ASAT Calculator and that the result is a VESDA **Fire** alarm threshold of 1.599%Obs/m (0.5%Obs/ft) as shown below (**Figure 8**).

Figure 8 – Output from the ASAT Calculator to be used for VESDA Fire alarm threshold evaluation in ASPIRE2.

1. Run the ASPIRE2 program. The following screen (Figure 9) will be displayed.

Figure 9 – General tab of the ASPIRE2 pipe network modelling program GUI.

2. Add a detector.
3. Add a pipe network.
4. On the General tab, set the **Fire** threshold to the value output by the ASAT Calculator, that is, 1.599%Obs/m (0.5%Obs/ft) in this case.
5. Click on the **Group Details** tab. The following screen (**Figure 10**) will be displayed. Set the upper limit **Target Aggregate Sensitivity** and **Target Hole Sensitivity** equal to the spot detector nominal sensitivity that has been input to the ASAT tool: 5%Obs/m (1.5%Obs/ft) in this case.

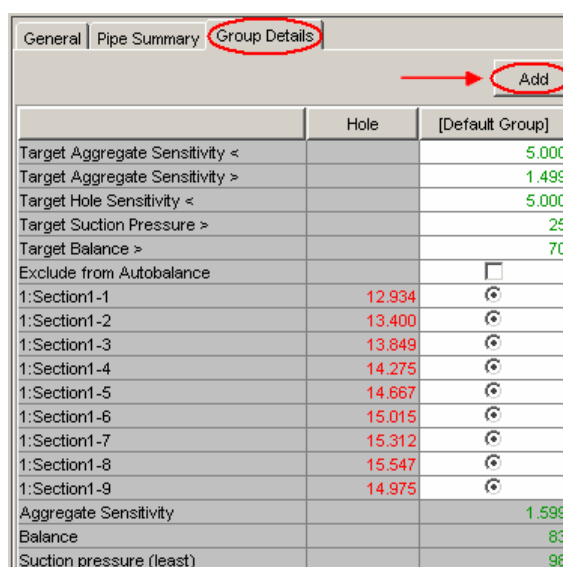


	Hole	[Default Group]
Target Aggregate Sensitivity <		5.000
Target Aggregate Sensitivity >		1.499
Target Hole Sensitivity <		5.000
Target Suction Pressure >		25
Target Balance >		70
Exclude from Autobalance		☐
1:Section1-1	12.934	☒
1:Section1-2	13.400	☒
1:Section1-3	13.849	☒
1:Section1-4	14.275	☒
1:Section1-5	14.667	☒
1:Section1-6	15.015	☒
1:Section1-7	15.312	☒
1:Section1-8	15.547	☒
1:Section1-9	14.975	☒
Aggregate Sensitivity		1.599
Balance		83
Suction pressure (least)		98

Figure 10 – Group Details tab of the ASPIRE2 pipe network modeling program GUI.

The sensitivity of each VESDA sampling hole is calculated on the assumption that smoke enters a specified hole only; with all other holes receiving clean air, which will dilute the aggregate sample. This is a very conservative assumption since smoke will spread throughout the enclosure, reaching multiple holes. The ASAT Calculator derived **Fire** alarm threshold is based on the fact that smoke will enter more than two VESDA sampling holes. It is therefore, appropriate to employ the Group Sensitivity concept for evaluating the **Fire** alarm threshold in ASPIRE2, rather than single hole sensitivity.

- Click on the **Add** button (Figure 11) to create a new group.



	Hole	[Default Group]
Target Aggregate Sensitivity <		5.000
Target Aggregate Sensitivity >		1.499
Target Hole Sensitivity <		5.000
Target Suction Pressure >		25
Target Balance >		70
Exclude from Autobalance		☐
1:Section1-1	12.934	☒
1:Section1-2	13.400	☒
1:Section1-3	13.849	☒
1:Section1-4	14.275	☒
1:Section1-5	14.667	☒
1:Section1-6	15.015	☒
1:Section1-7	15.312	☒
1:Section1-8	15.547	☒
1:Section1-9	14.975	☒
Aggregate Sensitivity		1.599
Balance		83
Suction pressure (least)		98

Figure 11 – Grouping sampling holes.

- Tick the sampling holes to appear in the group as shown (Figure 12). Three holes have been ticked here.

General Pipe Summary Group Details			
		Add	Delete
	Hole	[Default Group]	Clean Air
Target Aggregate Sensitivity <		5.000	5.000
Target Aggregate Sensitivity >		1.499	1.499
Target Hole Sensitivity <		5.000	5.000
Target Suction Pressure >		25	25
Target Balance >		70	70
Exclude from Autobalance		☐	☐
1:Section1-1	12.934	☒	☐
1:Section1-2	13.400	☒	☐
1:Section1-3	13.849	☒	☐
1:Section1-4	14.275	☐	☒
1:Section1-5	14.667	☐	☒
1:Section1-6	15.015	☐	☒
1:Section1-7	15.312	☐	☒
1:Section1-8	15.547	☐	☒
1:Section1-9	14.975	☐	☒
Aggregate Sensitivity		4.461	2.492
Balance		93	91
Suction pressure (least)		126	98

Figure 12 – Three sampling hole grouping.

Each of the three sampling holes must sample smoke at a level of 4.461%Obs/m (1.36%Obs/ft) in order for 1.599%Obs/m (0.5%Obs/ft) to be recorded at the VESDA detector. Note that the aggregate sensitivity, in this case, is less than the target hole sensitivity, therefore, the ASAT Calculator **Fire** alarm threshold value is reasonable.

8. Now make a group of four sampling holes, like that shown below (Figure 13).

General Pipe Summary Group Details			
		Add	Delete
	Hole	[Default Group]	Clean Air
Target Aggregate Sensitivity <		5.000	5.000
Target Aggregate Sensitivity >		1.499	1.499
Target Hole Sensitivity <		5.000	5.000
Target Suction Pressure >		25	25
Target Balance >		70	70
Exclude from Autobalance		☐	☐
1:Section1-1	12.934	☒	☐
1:Section1-2	13.400	☒	☐
1:Section1-3	13.849	☒	☐
1:Section1-4	14.275	☒	☐
1:Section1-5	14.667	☐	☒
1:Section1-6	15.015	☐	☒
1:Section1-7	15.312	☐	☒
1:Section1-8	15.547	☐	☒
1:Section1-9	14.975	☐	☒
Aggregate Sensitivity		3.399	3.019
Balance		90	94
Suction pressure (least)		118	98

Figure 13 – Four sampling hole grouping.

Each of the four sampling holes must sample smoke at a level of 3.399%Obs/m (1.036%Obs/ft) in order for 1.599%Obs/m (0.5%Obs/ft) to be recorded at the VESDA detector. Again, the aggregate sensitivity is less than the target hole sensitivity.

In summary, when evaluating ASAT Calculator **Fire** alarm threshold values, it is only necessary to consider the aggregate sensitivity of a group of sampling holes in relation to the target hole sensitivity. If the aggregate sensitivity of a group of holes is greater than the target hole sensitivity, the designer may consider one of the following options:

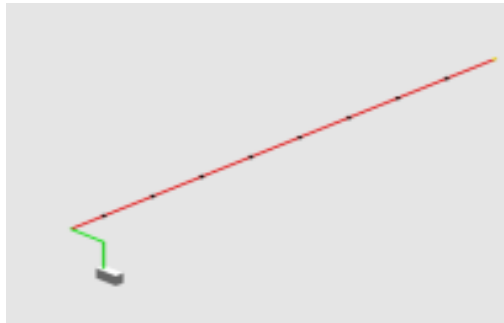
- Regrouping sampling holes.
- Adjusting the ASPIRE2 design.

Users wishing to recreate the example illustrated in this document can find the details of the ASPIRE2 design in the Appendix.

Appendix – Example ASPIRE2 Design File

Detector:

Type	VESDA LaserPLUS
Endcap Usage	Create a Balanced Design
Application	Default
Aspirator Speed	3000rpm
Fire Threshold	1.599%/m
Temperature	20.0°C
Absolute Pressure	1013.5hPa
System Flowrate	36.4l/min
Manifold Pressure	168Pa
Total Pipe Length	40.00m
Number Of Sampling Points	9
Maximum Transport Time	60sec
Minimum Hole Flow Rate	2.0l/min



Pipe:[New Pipe]	
Total Pipe Length	40.00m
Ambient Pressure	0Pa
Sector Pressure	168Pa
Number Of Sampling Points	9
Pipe Flowrate	36.4l/min

Section1

	Item	Distance m	Relative m	Hole Diameter mm	Capillary Length m	Transport Time sec	Pressure Pa	Flow l/min	Flow %	Hole Sensitivity %/m	Diameter mm
-	.Bend	2.67	2.67	-	-	-	-	-	-	-	-
-	Bend	5.34	2.67	-	-	-	-	-	-	-	-
1	Hole	8.00	2.66	3.0	-	5	144	4.5	12.4	12.934	21.0
2	.Hole	12.00	4.00	3.0	-	7	134	4.3	11.9	13.400	21.0
3	Hole	16.00	4.00	3.0	-	9	126	4.2	11.5	13.849	21.0
4	Hole	20.00	4.00	3.0	-	12	118	4.1	11.2	14.275	21.0
5	.Hole	24.00	4.00	3.0	-	15	112	4.0	10.9	14.667	21.0
6	Hole	28.00	4.00	3.0	-	18	107	3.9	10.6	15.015	21.0
7	Hole	32.00	4.00	3.0	-	23	103	3.8	10.4	15.312	21.0
8	.Hole	36.00	4.00	3.0	-	31	100	3.7	10.3	15.547	21.0
9	Endcap	40.00	4.00	3.0	-	45	98	3.9	10.7	14.975	21.0

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